Building the Trinity River Delta Hydrodynamic Model

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Find problem → Build model → Validate model → Apply model

Motivation

- Mismatch of flow rates between two gages

Ultimate Goal

- Identify the fate of flow
- Where and why

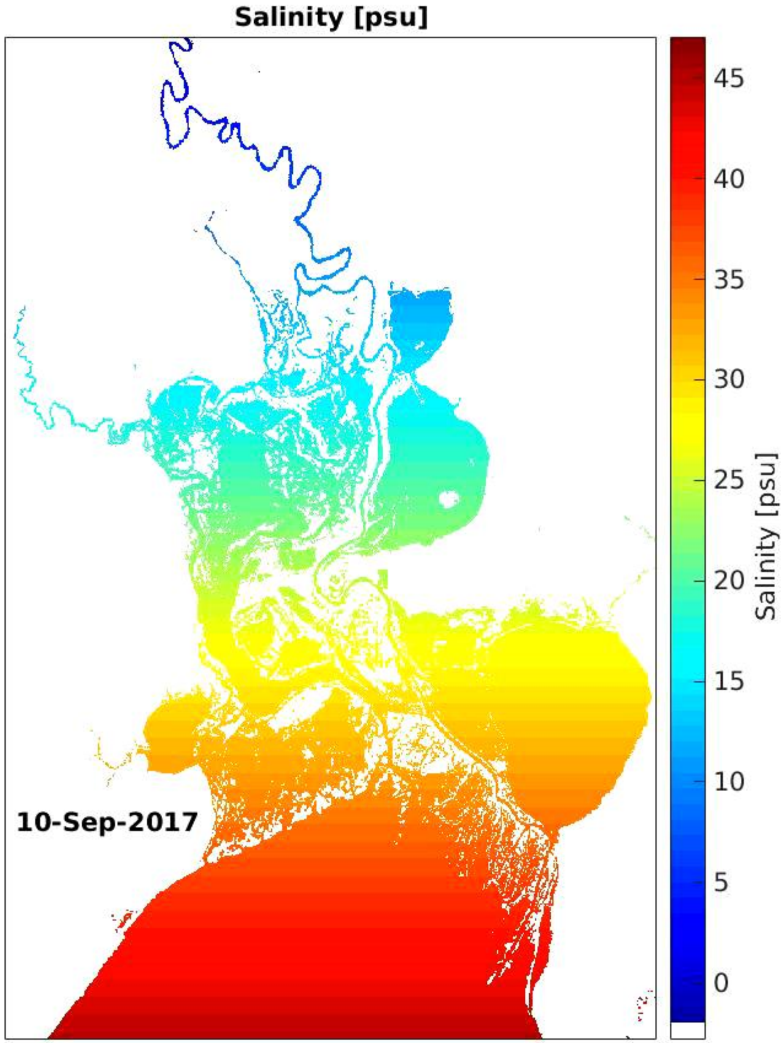
Approach

- Hydrodynamic modeling

Our job

- Build a model for Trinity Delta

Hydrodynamic model



Phase I: Hydrodynamic model development for the Trinity River Delta (Completed)

- Mobilizing lidar data and analysis of "not-a-number" (NaN) elements
- Field work for limited checking of NaN elements and bathymetry in some channels
- Analysis of landscape data and development of a hydrodynamic model

Phase II: Building the Trinity River Delta Hydrodynamic Model (In Process)

- Sensitivity testing of the TDHM
- Implementing subgrid-scale algorithms
- Adapting Frehd-C model for coupled surface/groundwater flows

Flowchart of Phase I

Analyze lidar data

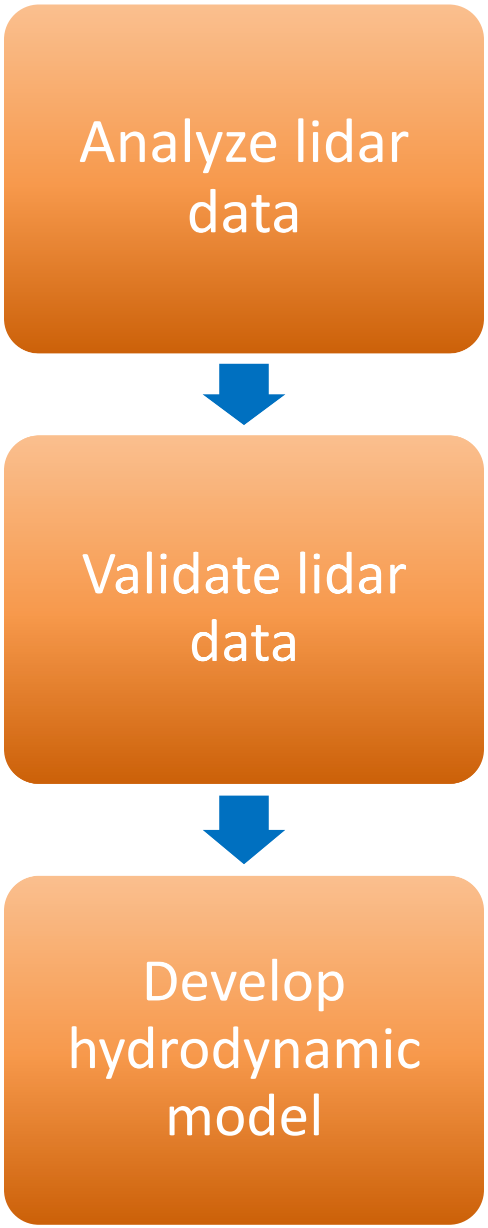
- Process raw lidar data to create raw topography
- Analyze possible errors in the topography
- Estimate bathymetry at locations without lidar measurement

Validate lidar data

- Collect field data for land elevation and water depth
- Check agreements between field data and lidar data

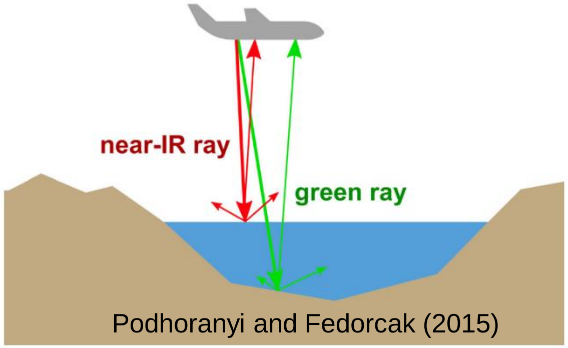
Develop hydrodynamic model

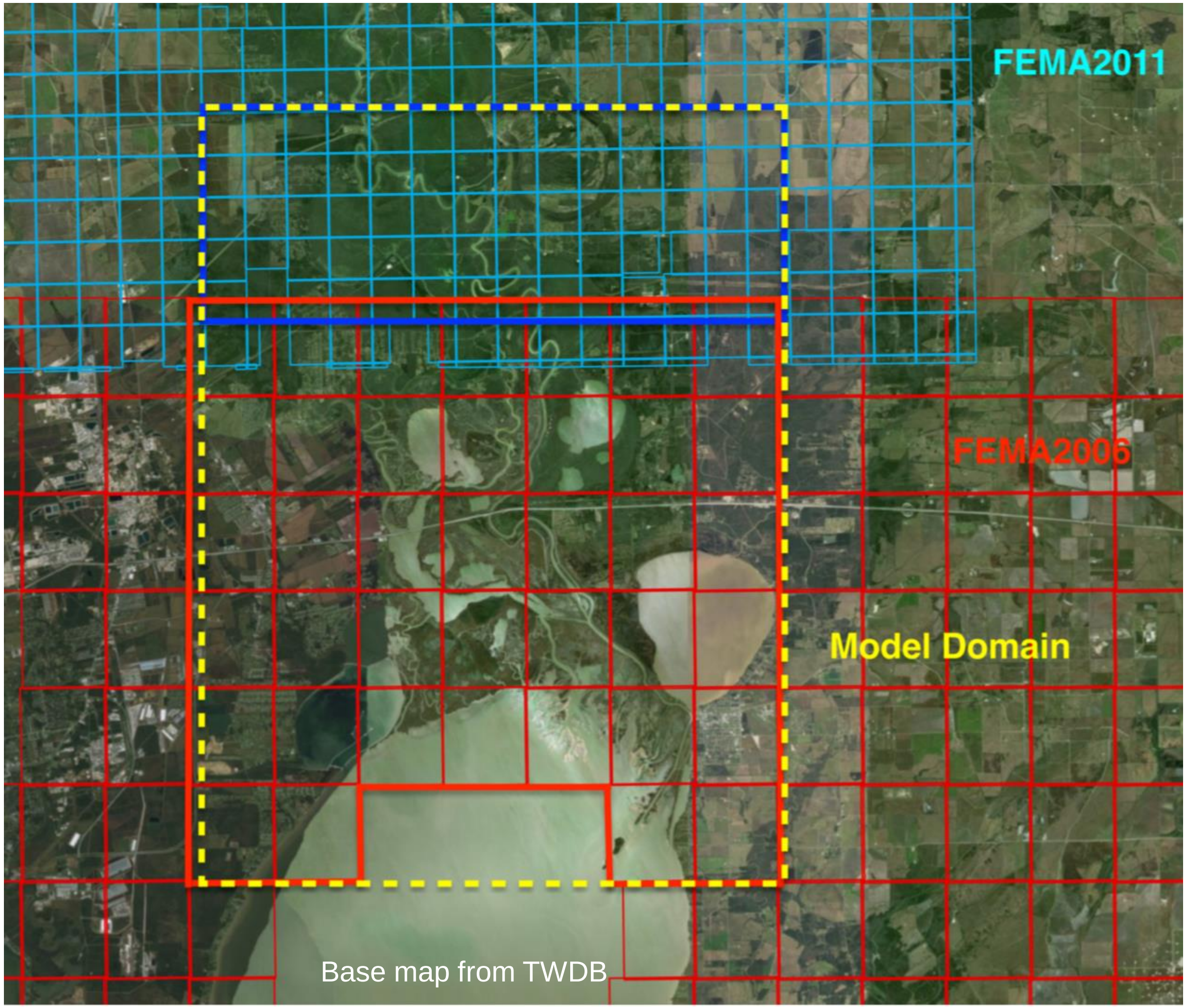
- Select the proper model for Trinity Delta
- Generate bathymetry as input to the model



Phase I
Task 1 – Analyze lidar data

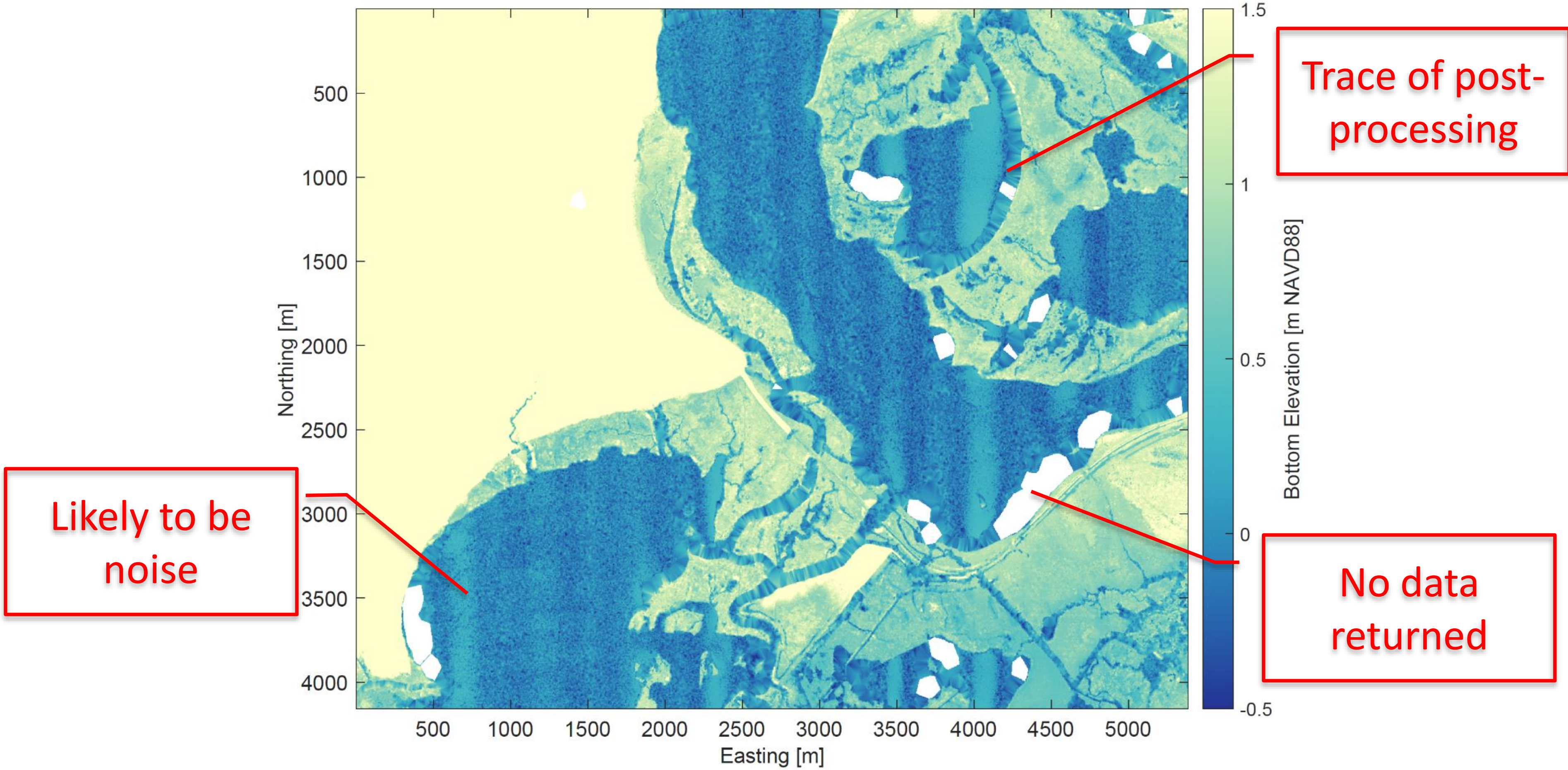
- Lidar
- Red lidar reflected at water surface





Phase I
Task 1 – Analyze lidar data

- Lidar data for wet regions are not trustworthy



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Analyze lidar data

↓

Validate lidar data

↓

Develop hydrodynamic model

Phase I

Task 2 – Validate lidar data

- Field survey with TWDB+TRA on Dec. 2016
- Trinity river **3m** deeper than that on lidar
- Land data is acceptable

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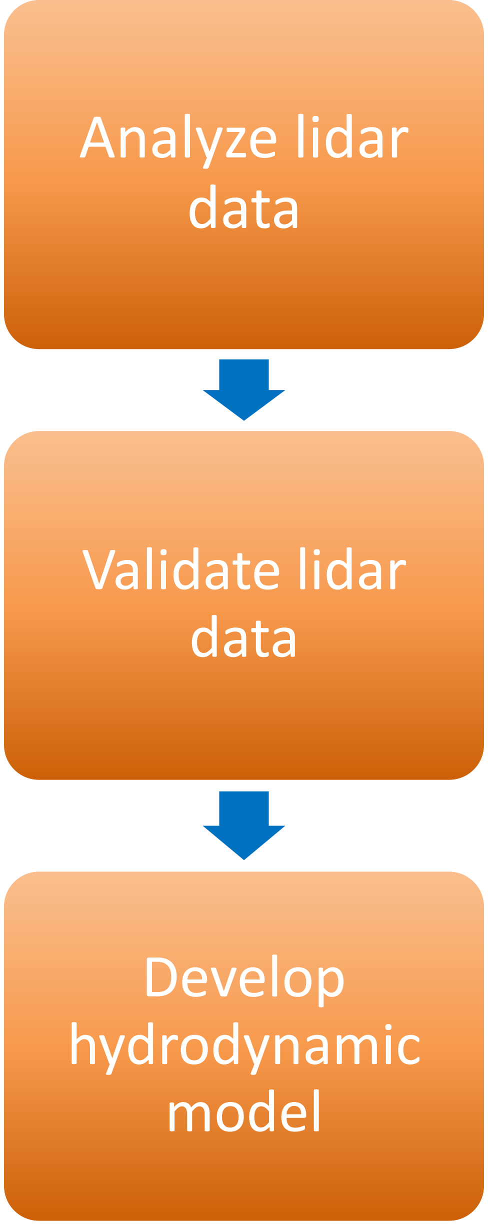


Phase I
Task 3 – Develop hydrodynamic model

- The finest bathymetry (at 1m x 1m grid scale) contains 27600 x 20790 grid cells

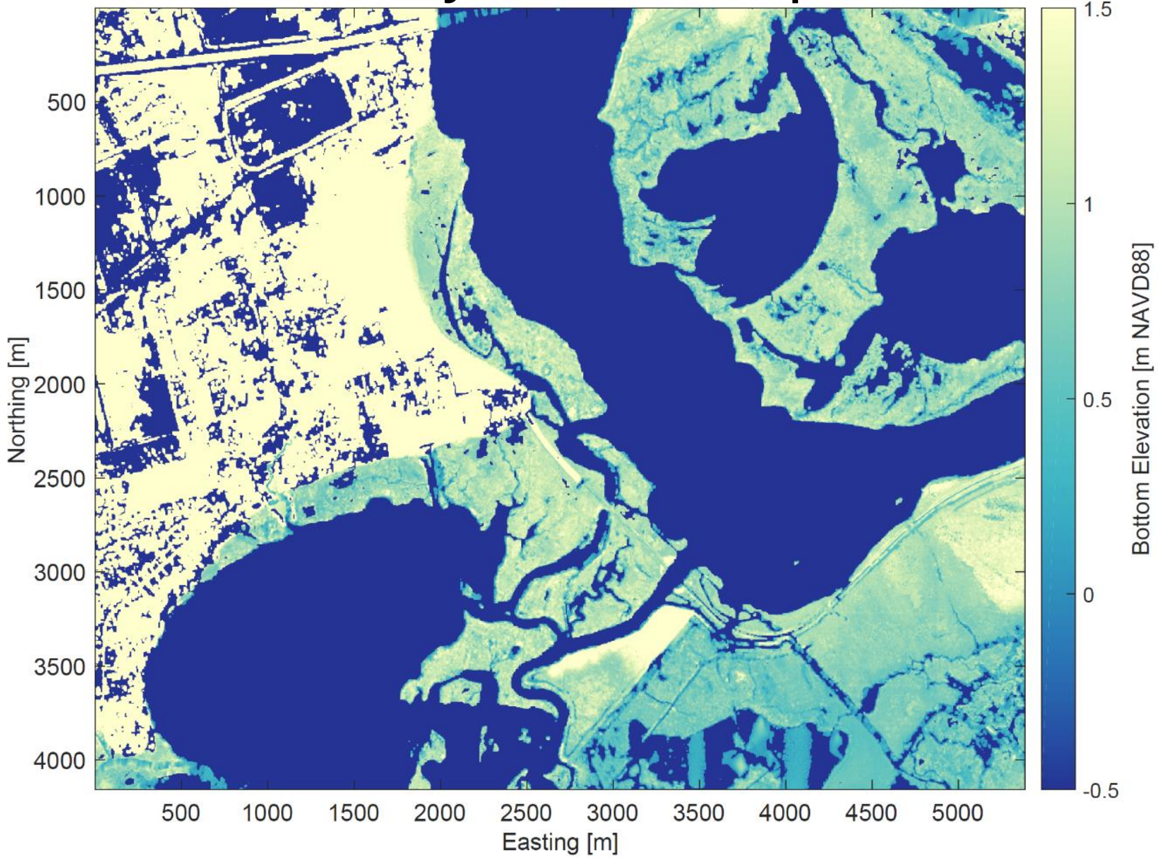
Candidate	Frehd	SUNTANS
Advantage	Easy to implement	Fast (easy to parallelize)
Disadvantage	Slow	Hard to build mesh

- Combine advantages of two models by parallelizing Frehd (Frehd-C)

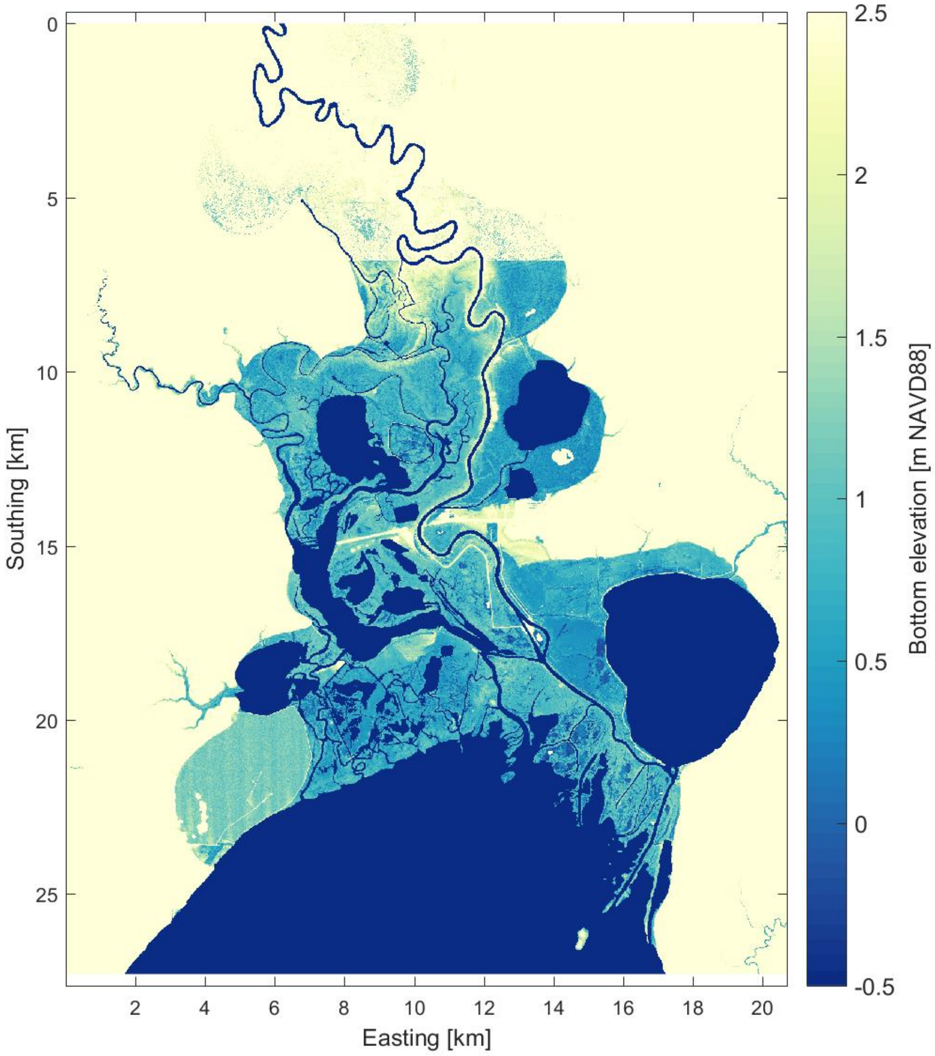
Phase I

Task 3 – Develop hydrodynamic model

- Automatic (unsupervised machine learning) + manual (Adobe Photoshop) approaches
- Need more data for fully automatic procedures



Final model bathymetry



Flowchart of Phase II

Test model sensitivity

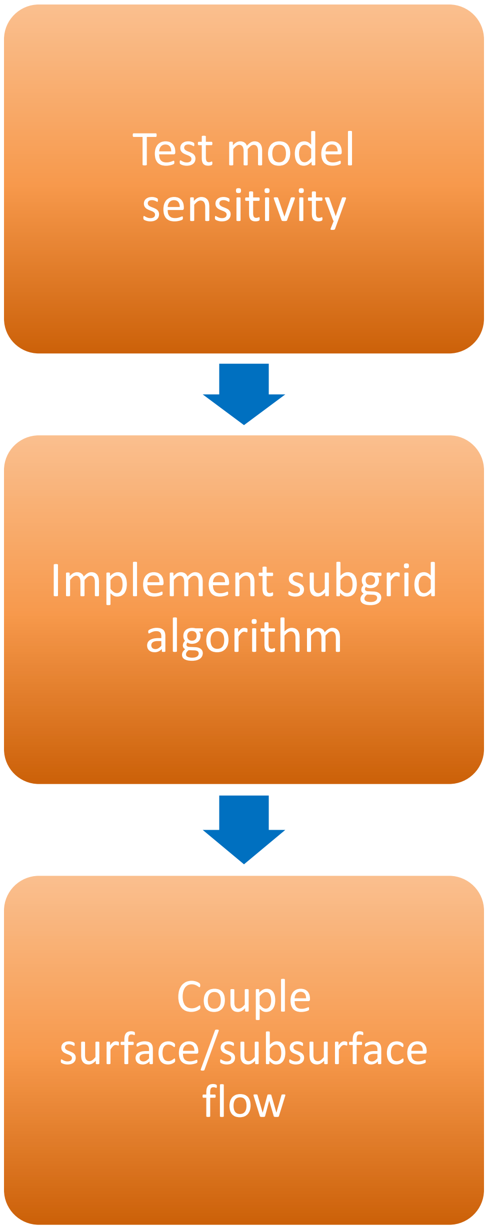
- Test model sensitivity to input (tide, wind, river stage)
- Analyze performance of uncalibrated model
- Provide recommendations on future field work

Implement subgrid algorithm

- Model small-scale processes at coarse resolution
- Analyze effectiveness of the subgrid algorithm

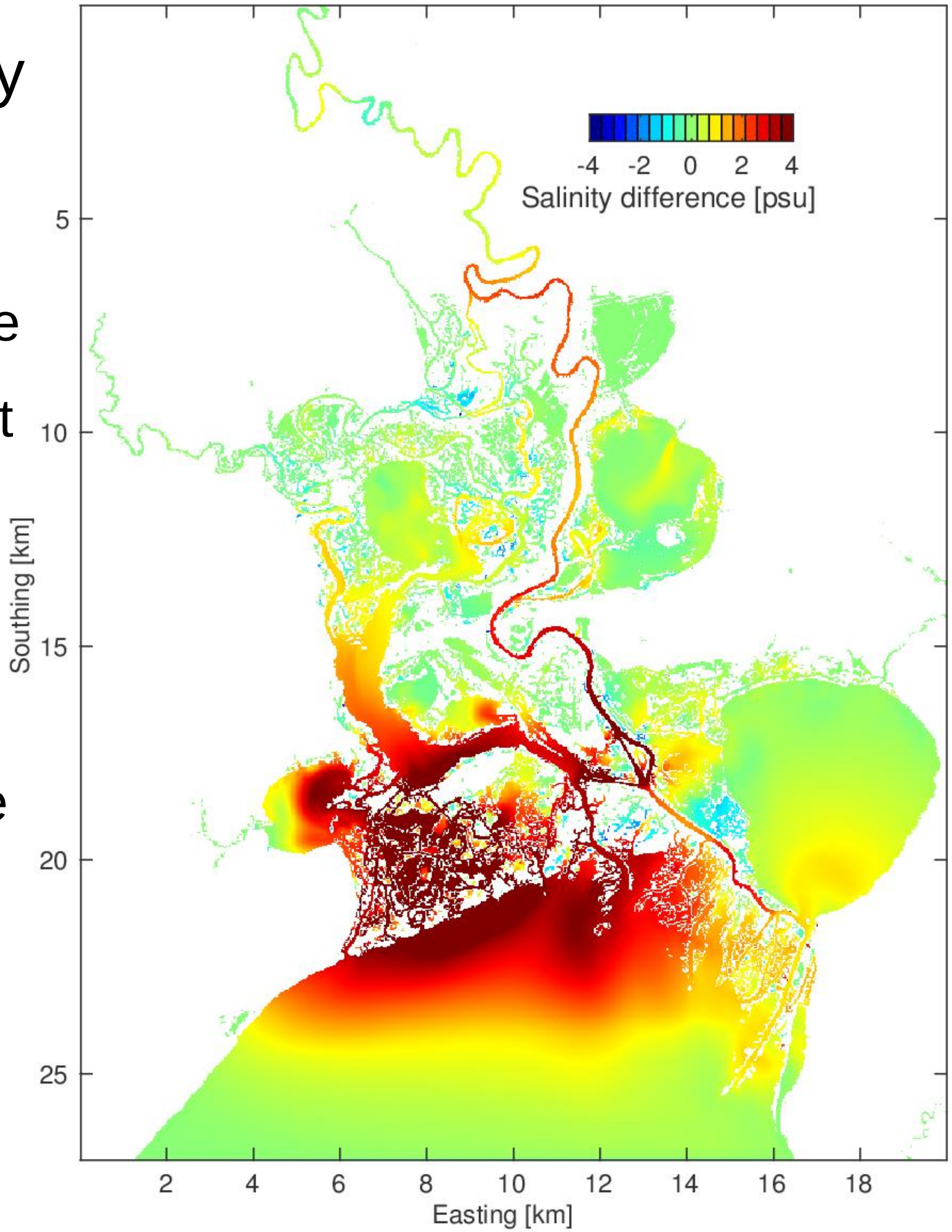
Couple surface/subsurface flow

- Investigate different approaches of surface-groundwater coupling



Phase II
Task 1 – Test model sensitivity

- Model has to be calibrated with field data (not available) before use
- Run simulations with different input values (tide, wind, inflow)
- Use salinity as a tracer, find locations where model is sensitive to inputs
- E.g. Lower delta is sensitive to tide



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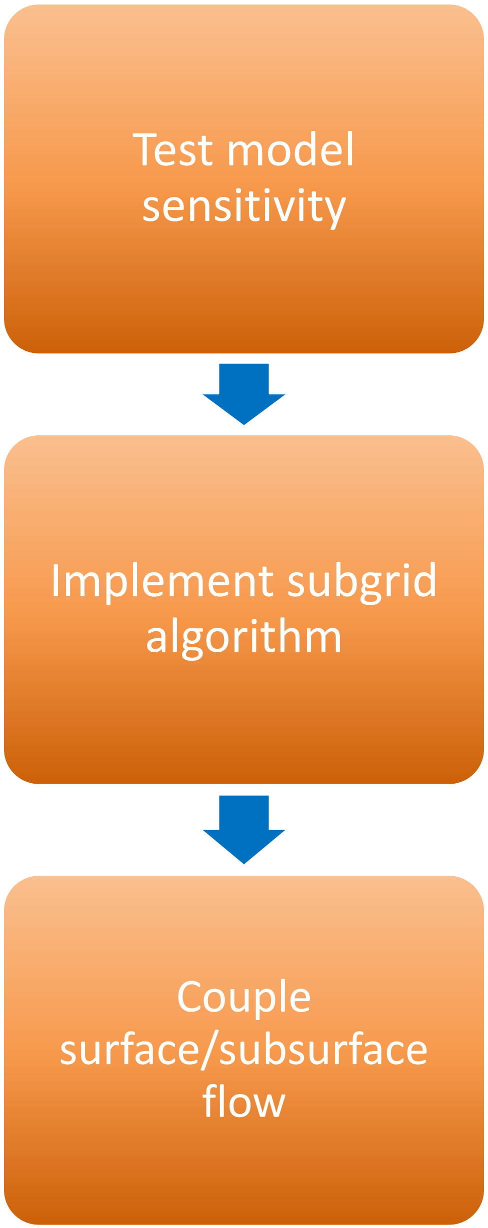

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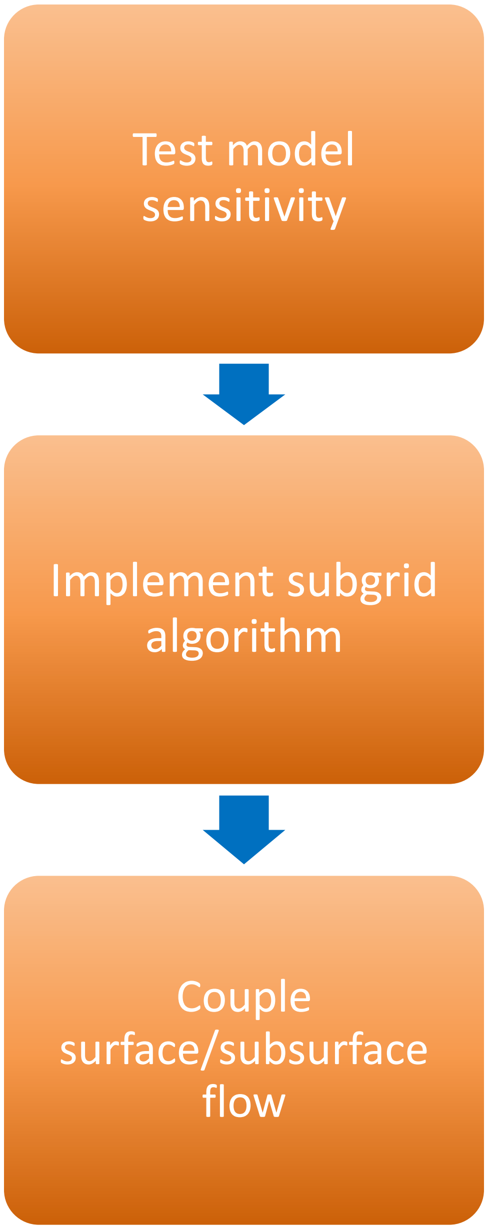

Conclusions

- The project is on schedule
- We have successfully built a hydrodynamic model for Trinity Delta
- Completing the remaining tasks (subgrid and groundwater model) will further improve applicability of TDHM
- Requires more field data to achieve the ultimate goal (identify flow mismatch)
- Once extensive field data is obtained, the model will be ready to use

Q&A